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WS 107A-1 FLIGHT TEST WORKING

FLIGHT TEST REPORT

ATLAS MISSILE 4F

GENERAL DYNAMICS | ASTRONAUTICS

23 November 1961

Log No. T 61-4304 Copy No. 47

AMR RANGE TEST NUMBER 3751

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FOREWORD

This report has been prepared to present preliminary information relative to the flight of Atlas Missile No. 4F. The information presented is based on visual observation and data evaluation to the extent permitted by time limitations. It should be considered as preliminary only, and the final reports on this flight referenced for further information. The technical content has been prepared and jointly agreed upon by members of the WS 107A-1 Flight Test Working Group.

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SUMMARY

Atlas Missile 4F, the second "F" Series Missile to be flight tested, was launched from Complex 11, AMR, at 1604 EST on 22 November 1961. The flight was successful and the Mark 5 Mod 2 Re-entry Vehicle impacted in the target area at a range of 4,388 nautical miles. MILS data placed impact within 1.2 nautical miles of the aim point.

Operation of all missile systems was satisfactory except that Umbilical 600U7 did not eject and was pulled out at liftoff, and re-entry vehicle playback data was not received after blackout.

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OBJECTIVES	ORDER	YES	NO	PART	COMMENT
1 - First 2 - Second 3 - Third					
Weapon System Objectives					
1. Determine the performance and repeatability of the missile sub-system and associated ground equipment.	2	X			
2. Evaluate the ability of the MAPCHE System and procedures to check out a missile and place it in a first readiness condition	1	X			
3. Obtain radar and/or radiation data during re-entry.	3				Awaiting delivery of downrange data.
4. Obtain data on the Re-entry Vehicle impact location for the statistical determination of CEP.	1	X			
5. Evaluate the performance of the Acoustica PU System.	1	X			
6. Evaluate the ARMA Inertial Guidance System performance and accuracy.	1	X			
7. Determine the flight performance of the fuel feed system.	2	X			
8. Evaluate the performance of the penetration systems.	2	X			Awaiting delivery of downrange data.

OBJECTIVES	ORDER	YES	NO	PART	COMMENT
9. Demonstrate the launcher compatibility with the "F" Series missile.	2	X			
Non-weapon System Objectives					
1. Evaluate the Mark 5, Mod 2 Re-entry Vehicle ablation material performance during re-entry.	2			X	Lost Link 255.1 mc during blackout.
2. Determine the Mark 5, Mod 2 Re-entry aerodynamic heating, loading and stability during re-entry.	2			X	
3. Determine the Mark 5, Mod 2 Re-entry Vehicle Separation and Arming and Fuzing sub-systems performance.	2			X	
4. Demonstrate the compatibility of the Mark 5, Mod 2 Re-entry Vehicle with the F Series missile, in particular, the Flight Control System.	2	X			
5. Evaluate the performance of the Sandia warhead systems.	2			X	

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FLIGHT TRAJECTORY

The flight of Atlas Missile 4F was planned for a range of 4388 nautical miles downrange with impact in the center of Ascension Missile Impact Location System (MILS) area.

This was the first "F" Series missile to be flown with a lofted trajectory.

A tabulation of miss distances and a comparison of nominal flight performance parameters from Flight Trajectory E XII, and measured test values from Azusa and telemetry data at significant times along the trajectory are presented below.

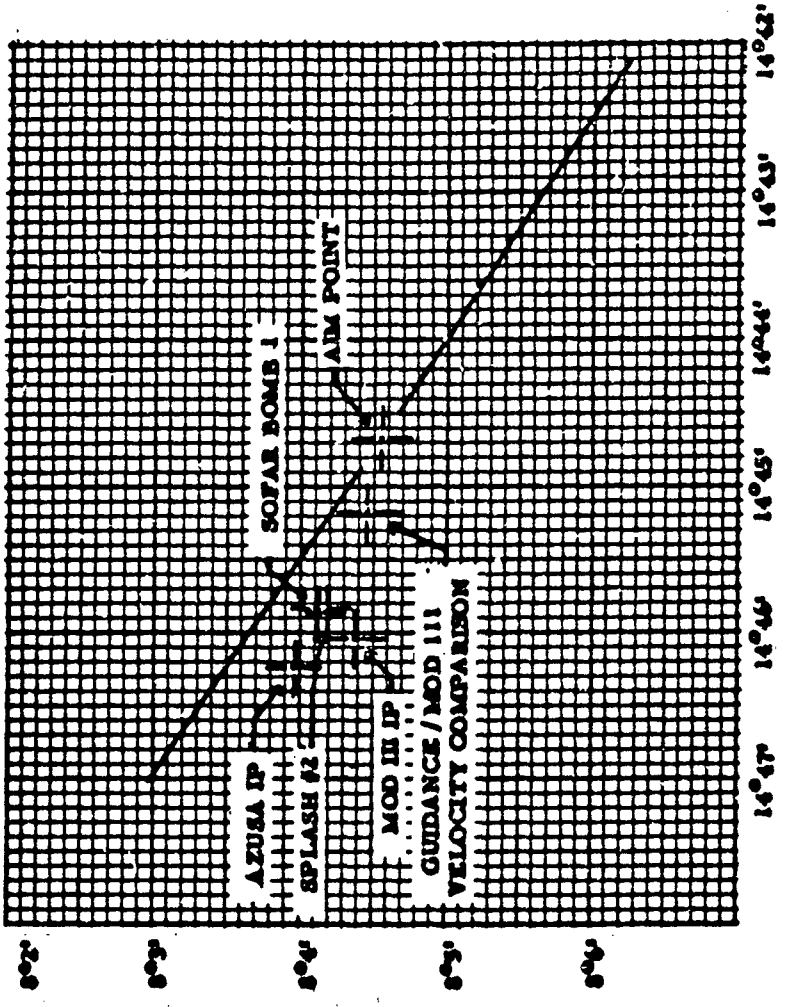
Figure 1 presents impact points as determined from several sources.

Note: All times in this report are based upon Range Zero Time which occurred at 1604:11 EST. One Inch Motion occurred at 1604:11.46 EST.

Source	Miss Distance	95% Confidence Limits
Azusa Mk 11	1.57 nm Short 0.32 nm Right	Major Axis 0.239 nm Minor Axis 0.215 nm @ 123.45°T
Mod III	1.23 nm Short 0.62 nm Right	Major Axis 0.42 nm Minor Axis 0.37 nm @ 123.1°T
Splash No. 2	1.14 nm Short 0.30 nm Right	σ_x 0.110 nm σ_y 0.107 nm @ -60.7°T
SOFAR Bomb 1	1.17 nm Short 0.30 nm Right	σ_x 0.115 nm σ_y 0.113 nm @ 27.6°T
Guidance/Mod III Velocity Comparison	0.50 nm Short 0.20 nm Right	-- -- --

Item	Unit	Nominal	Measured
Liftoff Weight	lbs	268,597	-
Launch Azimuth	deg	106.3	106.3
BCO Weight	lbs	67,870	-
BCO Velocity	ft/sec	9,035	9,080
BCO Altitude	ft	205,829	208,484
BCO Range	nm	42.4	42.3
BCO Time	sec	125.7	125.8
SCO Weight	lbs	15,513	-
SCO Velocity	ft/sec	20,113	20,126
SCO Altitude	ft	941,657	951,725
SCO Range	nm	384.5	375.8
SCO Time	sec	293.5	289.4
VCO Weight	lbs	15,317	-
VCO Velocity	ft/sec	19,992	19,985
VCO Altitude	ft	1,044,120	1,060,967
VCO Range	nm	440.2	433.8
VCO Time	sec	311.2	307.8
Impact Time	sec	1,954.1	1,969.3
Impact Range	nm	4,388	4,387
Impact Latitude (Geodetic)	deg S	8°4.56'	8°4.17'
Impact Longitude (Geodetic)	deg W	14°44.69'	14°45.83'

IMPACT POINT COMPARISON



Note: Nominal times are corrected for the difference between Range Zero and One Inch Motion. Measured velocity, altitude, and range at booster, sustainer, and vernier cutoff, are from Azusa revised data. Impact range and co-ordinates are taken from MILS Splash Net Data. Measured times are taken from telemetry recordings of discrete generations. Impact time is taken from the loss of re-entry vehicle signal. Altitude is height above launch horizontal. Velocity is speed relative to the earth's surface. Range is measured horizontal from the launch pad with the exception of impact range which is measured along the surface.

SYSTEM PERFORMANCE

AIRFRAME

Missile structural integrity was satisfactorily maintained throughout powered flight and well beyond re-entry vehicle separation. Booster separation was satisfactorily initiated as recorded by M 32 X, Conax Valve Command. Re-entry vehicle separation and Atlas/Thor retro-rocket operation were satisfactory as indicated by M 79 A, Missile Axial Acceleration Fine. ARMA data recorded peak axial acceleration values of 7.32 G's at BCO and 5.15 G's at SCO. Umbilical 600U7 did not eject either electrically or mechanically. A review of film data showed that separation was effected when the umbilical became taut. Before the umbilical came out the bulkhead at the aft end of the pod became widely separated from the pod. The bulkhead snapped back into place when the umbilical separated. There were no apparent detrimental effects on missile operation.

The two environmental temperature measurements in the engine compartment gave normal indications. A 638 T, Aft Side A Frame Q 2, recorded 112°F throughout booster phase and 93°F thereafter. P 671 T, Thrust Section Ambient Quad 4, remained steady throughout flight at 93°F. This was not typical of other flights as normally the temperature rises during sustainer phase.

The thermocouple reference junction in Pod 1, Measurement T 105 T, indicated an essentially constant temperature of 55°F.

Four temperature measurements were instrumented on the Thor retro-rocket. Three of the four measurements indicated valid data. However, M 177 T did not activate until 151 seconds. The maximum temperature recorded by each measurement is listed in the following table.

Measurement	Description	Maximum Temp in °F	Time in Seconds From Liftoff
M 177 T	V1 Thor Retro Nozzle	129	290
M 178 T	V1 Thor Retro Case	91	284
M 179 T	V2 Thor Retro Nozzle	122	280
M 180 T	V2 Thor Retro Case	Deleted prior to launch	

Five temperature measurements were instrumented on the missile skin near the Scientific Passenger Pod in order to study the skin heating characteristics due to aerodynamic flow in this area. The maximum temperature recorded by each measurement is listed in the following table.

Measurement	Station	Maximum Temp in °F	Time in Seconds From Liftoff
A 41 T	1038	187	149
A 42 T	1048	187	149
A 43 T	1054	196	149
A 44 T	1062	169	149
A 45 T	1075	169	149

Four temperature measurements were instrumented in the V2 fairing area. These measurements were added in order to study the aerodynamic heating characteristics of the new fairing and to determine the environmental temperatures of the Thor retro-rockets. The fairing configuration was changed in order to house the added Thor retro-rockets. Measurement A 31 T, V2 Heat Shield, activated at 63 seconds, rose to a maximum temperature of 477°F at 93 seconds, then started a decrease and was indicating zero by 128 seconds. A 32 T, V2 Heat Shield Calorimeter, did not function throughout the flight. A 57 T, at the forward retro-rocket support, indicated a maximum temperature of 108°F at vernier cutoff. Measurement A 679 T, V2 Fairing Aft, began an increase at 68 seconds and indicated a maximum temperature of 284°F by 121 seconds.

The V2 clamshell was instrumented with two temperature measurements. Measurement A 142 T, V2 Pitch Feedback Electrical Connector, rose to a maximum temperature of 169°F at 116 seconds. A 143 T, V2 Clamshell Inner Surface, indicated 204° at booster cutoff and 302° at 270 seconds.

An accelerometer, Measurement A 36 A, was mounted on the booster thrust section to analyse the longitudinal motion of the thrust section as it jettisons. Any sudden impacts or hitches in the thrust section movement was to be revealed by this accelerometer. The accelerometer was attached to the booster thrust section and utilized an eight foot cable. No valid data was gathered from this measurement. The measurement apparently became inoperative immediately after liftoff.

Two other accelerometers were instrumented on the booster section jettison rail end in order to ascertain that the rail deflections are within specifications. One accelerometer was to measure acceleration in the tangential direction and the other was to measure acceleration in the radial direction. Measurement A 77 A, Jettison Rail End, Radial, apparently yielded invalid data.

A 78 A, Jettison Rail End, Tangential, appeared to give valid indications, showing minor movement during staging. Further evaluation will be required to determine the value of the data recorded by this measurement.

At booster staging, a significant quantity of LO2 and fuel is trapped in the jettisoning thrust section. The trapped LO2 either quickly vaporizes or mixes with the fuel and actually explodes. The phenomenon may explain the observed missile nose-up which occurs right after the start of the booster jettison operation. Four measurements, two pressure transducers and two low mass thermistors, were provided in order to make a study of the above described phenomenon. The two pressure transducers, Measurements A 59 P, Ambient B1 LO2 Staging Disconnect, and A 60 P, Ambient B2 LO2 Staging Disconnect, indicated some pressure variation just prior to the telemetry blackout period. The two thermistors, Measurements A 35 T, Ambient B1 LO2 Staging Disconnect, and A 58 T, Ambient B2 LO2 Staging Disconnect, recorded temperature decreases at liftoff and at booster staging. It appears that the blips indicating temperature decreases at staging were followed by blips indicating increases. Further evaluation is required to determine the full significance of this data.

PROPULSION SYSTEM

The Propulsion System performance was satisfactory throughout all phases of the flight. Engine thrust rises and decays appeared normal. Sustainer engine ignition delay time was not acquired due to the EA recorders being on slow time.

In order to evaluate sustainer engine performance during the staging blackout, a time delay recording of RF 1 was transmitted on RF 4. Also additional instrumentation was added which consisted of Sustainer Gas Generator (SGG) Fuel Check Valve Acceleration (P 531 O), Sustainer LO2 Regulator Output Pressure (P 967 P), SGG Fuel Injection Manifold (P 463 P), Sustainer Fuel Injection Manifold Pressure (P 517 P) and SGG LO2 Injection Manifold Pressure (P 337 P). No abnormal activity was noted on sustainer engine pressure measurements during staging.

Interpretation of the SGG fuel check valve acceleration data was difficult because of the large range of the accelerometer (300 G's). The average accelerations were 8 G's at liftoff, 10 G's prior to BCO, and 9 G's prior to SCO. The acceleration level remained fairly constant throughout sustainer engine firing at a frequency of 600 to 640 cycles per second.

A tabulation of Propulsion System telemetered data is presented on the following pages.

PROPULSION SYSTEM TIME SLICE DATA

Measurement No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO	TLM Prior to VCO
Booster Engines								
P 155 P	B1GG Combustor	psia	478	-	480	520	-	-
P 184 P	B2GG Combustor	psia	478	-	480	520	-	-
P 713 T	B1GG Combustor Temp	dgf	1232*	-	1230	1250	-	-
P 714 T	B2GG Combustor Temp	dgf	1275*	-	1230	1230	-	-
P 473 P	B1 Lo Pr Lube Oil Man	psia	-	-	120	108	-	-
P 279 P	B2 Lo Pr Lube Oil Man	psia	-	-	150	141	-	-
P 4 P	B2 Fuel Pump Inlet	psia	-	72.8	67	54	-	-
P 1026 T	B1 LO2 Pump Inlet Temp	dgf	-	-287	-	-	-	-
P 1054 T	B2 LO2 Pump Inlet Temp	dgf	-	-286	-	-	-	-
P 84 B	B1 Pump Speed	rpm	6096*	-	6110	6305	-	-
P 83 B	B2 Pump Speed	rpm	6184*	-	6180	6378	-	-
P 2 P	B1 Fuel Pump Inlet	psia	-	62.7	69	53	-	-
P 39 P	B1 Fuel Pump Disch	psia	840*	-	810	830	-	-
P 38 P	B2 Fuel Pump Disch	psia	841*	-	**	**	-	-

Measurement No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO	TLM Prior to VCO
P 91 P	B1 LO2 Inj Man	psia	677	-	660	700	-	-
P 92 P	B2 LO2 Inj Man	psia	677	-	660	710	-	-
P 66 P	B1 Thrust Chm	psia	573*	-	560	592	-	-
P 59 P	B2 Thrust Chm	psia	574*	-	568	608	-	-
P 1711 T	B1 Nacelle Ambient	dgf	-	74	-	-	-	-
P 1712 T	B2 Nacelle Ambient	dgf	-	75	-	-	-	-
Sustainer Engine								
P 337 P	SGG LO2 Inj Man	psia	850	-	880	900	870	-
P 709 T	SGG Combustor Temp	dgf	1052	-	885	930	835	-
P 341 P	S Lube Oil Man	psia	-	-	645	645	615	-
P 56 P	S LO2 Pump Inlet	psia	-	-	67.5	111	78	-
P 530 T	S LO2 Pump Inlet Temp	dgf	-	-	**	**	**	-
P 55 P	S Fuel Pump Inlet	psia	-	65.6	75	69	35	-
P 349 B	Sus Pump Speed	rpm	10112*	-	10155	10200	10350	-
P 529 D	S Main LO2 Valve	deg	-	-	**	**	**	-
P 830 D	PU Valve	deg	27.3*	-	29.5	22.5	27.0	-

Measurement No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO	TLM Prior to VCO
P 338 P	S Fuel Pump Disch	psia	1000	-	960	960	930	-
P 351 P	S LO2 Inj Man	psia	806	-	810	850	800	-
P 6 P	S Thrust Chamber	psia	693*	-	690	700	700	-
P 1718 T	S Eng Environment	dgf	-	84	-	-	-	-
P 967 P	LO2 Regulator Out	psia	886*	-	880	880	880	-
P 463 P	SGG Fuel Inj Man	psia	845	-	830	820	820	-
P 517 P	S Fuel Inj Man	psia	757	-	**	**	**	-
Vernier Engines								
P 1474 P	Vern Ctl Press Reg Out	psia	605	601	-	-	-	-
P 30 P	Vernier LO2 Tank	psia	585	-	40	40	570	540
P 27 P	Vernier Fuel Tank	psia	585	-	100	630	640	540
P 28 P	V1 Thrust Chamber	psia	353/298	-	330	338	362	302
P 29 P	V2 Thrust Chamber	psia	353/298	-	337	337	362	302
Miscellaneous								
P 1325 T	Eng Comb Amb	dgf	-	88	-	-	-	-

Measurement No.	Description	Units	Nominal Values	L/L at Liftoff	TLM After Liftoff	TLM Prior to BCO	TLM Prior to SCO	TLM Prior to VCO
P 671 T	Thrust Section Ambient	dgf	-	-	78	74	86	-

* Value from Engine Acceptance Test Log.

** Instrumentation malfunction

PROPELLANT UTILIZATION

The Acoustica Propellant Utilization (PU) System performance was satisfactory. The PU valve positioned correctly in response to the error counter output voltage. The Head Suppression valve position data was not valid.

The monostable output Measurement ((U 135 X) indicated simultaneous uncovering of the LO2 and fuel sensors at Stations 2 and 6. At both stations the computer interpreted the signals as LO2 sensor only uncoverings. In both instances the system positioned the PU valve at the maximum open position until automatic computer reset. At reset, the fail-safe feature of the system positioned the PU valve at the nominal value angle until Station 3 sensor uncovering and SCO, respectively.

Sensor uncovering times and PU valve angle after positioning are shown in the following table

Station	LO2 * Sensor	Fucl * Sensor	PU Valve Angle
1	8.97	8.27	23.5
2	48.51	48.51	27.0
3	86.15	85.30	21.5
4	117.24	116.79	26.0
5	192.84	192.29	26.5
6	246.15	246.15	27.0

* Accuracy of times is ±0.05 seconds.

Calculations of propellant residuals based on Head Sensing Port data indicated 755 pounds of fuel and 2055 pounds of LO2 remaining at SCO. This represents a LO2 excess of 340 pounds at SCO.

The following constants were applicable for this flight:

CA 108 B Computer Serial Number 0086

PU Valve Angles

	Calibrated Values	Log book Values
Closed Limit	22.0°	22.5°
Nominal	27.5°	27.3°
Open Limit	47.0°	47.5°

PNEUMATIC SYSTEM

System performance was satisfactory. Telemetered data indicated that all pressurization and control functions were properly performed throughout flight.

Tank Pressurization System

Missileborne propellant tank pressures were satisfactorily maintained within respective LO2 and fuel tank pressure specifications of 23.0 to 25.5 psig and 57.0 to 62.0 psig until jettison of the Fluidgenics pressurization regulators with the booster section.

LO2 boiloff continued to maintain LO2 tank pressure at 25 to 26 psig during sustainer/vernier phase and until well after re-entry vehicle separation. Fuel tank pressure decayed from 59 psig at BCO to 40 psig at VCO, reflecting the bulkhead heat transfer rate associated with the uninsulated intermediate bulkhead.

The Pneumatic System configuration of "F" Series missiles utilizes 6 helium bottles for propellant tanks pressurization whereas only 5 are used for "E" Series missiles. The bottle was added since the operational "F" Series missile will have a shorter chilldown time and the final bottle temperature will be higher. However, since the bottles on Missile 4F were charged and cooled to nominal "E" Series R and D temperature and pressure, the expected excess stored helium was indicated at staging. Bottle pressure at that time was 1000 psia, or approximately 250 psi higher than on "E" Series flights. The bottle temperature decreased from -320°F at liftoff to -370°F at BCO.

The temperature increase effected in the helium when passing through the heat exchanger was 565°F at 5 seconds and 660°F at BCO. The maximum temperature rise of 755°F was recorded at 60 seconds when the LO2 pressurization regulator inlet temperature peaked at 403°F.

Control Pressurization System

Controls helium bottle discharge pressure data indicated that control pressure was properly maintained throughout flight. Landline measurements indicated bottle pressure and temperature of 3071 psia and 103°F at liftoff. Bottle pressure was 2920 psia at staging and normal decay occurred during vernier solo phase, reflecting a helium demand by the helium pressurized vernier engine solo propellant tanks.

Specific values from landline and telemetry data are presented on the following page.

PNEUMATIC SYSTEM TIME SLICE DATA

Measurement No.	Description	Units	Landline	After Liftoff	Prior to BCO	Prior to SCO	Prior to VCO
F 1 P	LO2 Tank Helium	psia	38.0	38	25	26	26
F 3 P	Fuel Tank Helium	psia	73.2	72	59	40	40
F 246 P	B Tank He Bottles Hi	psia	3066	2770	1050	-	-
F 247 T	B Tank He Bottles	°F	-	-330	-370	-	-
F 115 T	LO2 Press Reg Inlet	°F	-	235	290	-	-
F 145 P	S Ctl He Btl Disch	psia	3071	2980	2920	2880	1890
F 1290 T	S Ctl He Bottle	°F	103	-	-	-	-
F 1050 P	PCU LO2 Sensor Line	psia	40.0	-	-	-	-
F 1047 P	PCU Fuel Sensor Line	psia	90.0*	-	-	-	-
F 1194 P	Facility GN2 Supply	psia	1710	-	-	-	-

* Maximum value, data oscillating

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HYDRAULIC SYSTEMS

Systems performance was satisfactory. Booster and Sustainer/Vernier System pressures were properly maintained throughout powered flight. All high and low system pressure instrumentation yielded valid data with the exception of Measurement H 130 P, Sustainer Hydraulic Pump Discharge Pressure.

Booster system hydraulic accumulator pressure reflected normal transfer from the ground booster Hydraulic Pumping Unit pressure of about 1900 psia to a missileborne level of about 3150 psia which was satisfactorily maintained until BCO.

Sustainer/Vernier System hydraulic pressure reflected normal transfer from the ground sustainer Hydraulic Pumping Unit pressure of about 1930 psia to a missileborne level of about 3020 psia which was satisfactorily maintained until SCO.

Measurement H 185 P, Sustainer Hydraulic Pump Inlet Pressure, reflected an abnormal 20 psi pressure increase to 100 psia at hydraulic pump shutdown coincident with SCO, where it remained for the remainder of telemetered data. Since the Vernier System return pressure did not reflect the increase but remained at proper levels throughout flight, the pump inlet data after SCO is considered questionable. Flight data from Missile 2F indicated the same type of failure at the same time.

After SCO, hydraulic pressure was maintained by the Vernier Solo Accumulator for 33 seconds, bottoming out at a pressure of 870 psia.

Sustainer hydraulic pump vibration measurements were included in system instrumentation. Laboratory tests have shown that the sustainer hydraulic pump case fractures under certain vibratory conditions. The four measurements, added to determine if critical levels were being approached during flight, were:

H 426 O	Sustainer Hydraulic Pump, Tachometer X-Axis
H 427 O	Sustainer Hydraulic Pump, Tachometer Y-Axis
H 428 O	Sustainer Hydraulic Pump, End X-Axis
H 429 O	Sustainer Hydraulic Pump, End Y-Axis

All four measurement yielded valid data. Measurement H 429 O consistently indicated the highest vibration levels with maximum noted values of 20 to 23 G's (RMS).

HYDRAULIC SYSTEMS TIME SLICE DATA

Measurement No.	Description	Units	Landline	After Liftoff	Prior to BCO	Prior to SCO	Prior to VCO
H 33 P	B1 Hyd Accumulator	psia	-	3150	3150	-	-
H 224 P	B Hyd Sys Low Press	psia	-	86	90	-	-
H 140 P	Sus/Vern Hyd Press	psia	-	3020	3000	3020	1270
H 191 P	S Hi Press to Manifold	psia	-	3050	3050	3050	-
H 130 P	S Hyd Pump Disch	psia	-	*	*	*	*
H 185 P	S Hyd Pump Inlet	psia	-	77	85	82	100
H 212 P	Vernier Return	psia	-	77	83	79	73
H 1360 P	HPU Sustainer Return	psia	81.0	-	-	-	-

* Instrumentation malfunction

SECRET

MISSILE ELECTRICAL SYSTEM

System performance was satisfactory. Flight data indicated that electrical power was properly supplied to all user systems throughout flight and that all parameters remained within specification.

Measurement E 118 V, Engine Relay Box DC, was added to system instrumentation to monitor the dc voltage out of the engine relay box on a continuous telemetry channel to determine that no voltage interruptions occurred during flight. No voltage interruptions were indicated.

The following maximum and minimum values were recorded for the measurements listed below during the period from liftoff to after re-entry vehicle separation.

Measurement No.	Description	Units	Specification	Flight Min.	Flight Max.
E 50 Q	400 Cycle AC Power Supply	cps	395 to 405	398.8	400.6
E 28 V	Missile System Input	vdc	25.2 to 30.8	27.3	28.3
E 51 V	400 Cycle AC Phase A	vac	113 to 117	114.1	114.5
E 53 V	400 Cycle AC Phase C	vac	113 to 117	114.0	115.0

RANGE SAFETY COMMAND SYSTEM

Operation of the Range Safety Command System was satisfactory. Telemetered data indicated airborne received signal strength was adequate to ensure proper system operation until well beyond Nose Cone separation. The Automatic Sustainer Cutoff (ASCO) and Manual Fuel Cutoff (MFCO) signals were properly decoded by the missileborne system. Data indicated that sustainer cutoff was initiated by the Guidance System and not the ASCO signal.

The following times were obtained from the data. Signal D 1 V, RSC Cutoff Output, could only be measured with an accuracy of ±0.1 seconds on a commutated channel monitoring this signal because the continuous channel did not function properly.

Sustainer Cutoff Discrete	289.486
Sustainer Cutoff Relay	289.489 ± 0.1
Automatic Sustainer Cutoff	289.623 ±0.1
Manuel Fuel Cutoff	331.461 ±0.1

AZUSA SYSTEM

Operation of the Azusa System during flight was satisfactory. The telemetered airborne receiver AGC data and the ground station receiver AGC data increased rapidly at launch but remained noisy until approximately 80 seconds due to flame effects, lobing, and multi-path reception. Thereafter AGC data were clean and adequate until well beyond nose cone separation.

The system was in the fine mode in Range at launch. Automatic Track was established at 4.55 seconds and the angle cosines were switched to the fine mode at 5.45 seconds. Intermediate Range was transmitted from 20.6 to 24.1 seconds and one ambiguity was resolved from the "L" angle cosine from 47.6 to 48.4 seconds. Data were then satisfactory until 466 seconds where all parameters needed resolution. Loss of signal occurred at 475 seconds. Data was reducible from 25 to 399 seconds.

The Automatic Data Select Function at the 7090 Computer selected Azusa data for IP information from 58.3 to 120.9 seconds and from 212.7 to 467 seconds. The following IP was provided.

	Miss Distance	95 % Confidence Limits
Downrange	1.57 nm Short	Major Axis 0.239 nm
Crossrange	0.32 nm Right	Minor Axis 0.215 nm at 123.45° T

PENETRATION SYSTEM

A Mod I Pod, Serial Number 022, was flight tested on Atlas Missile 4F. The flight was completely successful. All of the Pod functions operated as planned.

The Baro Switch activated at 26.3 seconds providing voltage for instrumentation.

The sequence timer started at 292 seconds and supplied all the signals for fairing eject, tube unlatch and orient motor start.

The T2 signal was received from the flight programmer and initiated the canister ejection. The canister ejection velocity was approximately 10 ft/sec. The orient angle was approximately 82°.

Event	Time
Fairing Eject	292.6
Tube Unlatch	293.2
Orient Motor Start	294.0
Canister Eject	311.5

FLIGHT CONTROL SYSTEM

Performance of the Flight Control System was satisfactory. Data indicated that response to the guidance roll maneuver was satisfactory and that the pitch program was accomplished satisfactorily. All guidance discrete commands were acted upon properly and response to guidance steering commands was satisfactory. Data indicated that all programmer switch functions occurred properly. There were no missile bending mode buildups during the flight and propellant slosh during booster phase was moderate. Engine displacements at engine start were within the allowable tolerance of $\pm$ 0.6 degrees. The liftoff transient was larger than normal reaching 2.2 degrees peak displacement and a 4.8 deg/sec peak rate. This transient was comparable to that observed on Missile 16E. The staging transients and the staging sequence appeared normal. The vernier engine displacements reached 22 degrees to cause clockwise roll at approximately 47.5 seconds and moved to displacements of 7 degrees to cause counter-clockwise roll by 69.5 seconds. This unusual deflection at 69.5 seconds was comparable to that noted during the Missile 25E flight and was attributed to aerodynamic loading on the scientific passenger pods.

This was the first flight with Thor Retro-rockets closed-loop. These retro-rockets were fired simultaneously with the Atlas Retro-rockets by a separate programmer switch. Shorting of both the Atlas and the Thor Retro-rockets wiring resulted in the burnout of their respective programmer switch current limiters. The tank fragmentation signal instrumented in an open-loop configuration, occurred satisfactorily at 189.0 seconds after vernier cutoff.

INERTIAL GUIDANCE SYSTEM

Performance of the Inertial Guidance System was satisfactory. The roll maneuver and the pitch and yaw steering commands were properly generated. All discretes were issued at the times called for by the equations. All Inertial Mode start occurred at 1604:05.66 EST.

This was a lofted flight using Trajectory E-XII, with planned impact coordinates of 8.0760 degrees south latitude and 14.7450 degrees west longitude, a range of 4388 nautical miles. Target offsets of -0.0113 degrees latitude and ∕0.0078 degrees longitude were inserted in the Inertial Guidance System to compensate for nose cone parameters and vernier thrust decay.

Missile Behavior

Missile axial acceleration at sustainer cutoff was as follows:

	Nominal	Actual
Thrust Acceleration	5.22	5.21
Net Acceleration	4.74	4.73

A comparison of the telemetered velocities and positions with those listed in Trajectory E-XII at the approximate time of guidance enable was as follows:

Function	Units	Actual	Nominal	Difference*	3 Sigma Limits
Time**	sec	137.8125	138.00	-0.1875	∕ 6.5
$\dot{X}$	ft/sec	9666.5	9666.5	0	∕ 70
$\dot{Y}$	ft/sec	401.75	483.25	-81.5	∕ 600
$\dot{Z}$	ft/sec	4335.5	4233.0	∕102.5	∕ 900
X	ft	495,552	494,528	∕1024	∕ 19,500
Y	ft	56,064	58,304	-2240	∕ 25,500

Function	Units	Actual	Nominal	Difference*	3 Sigma Limits
Z	ft	237,568	234,176	∮3392	∮ 28,500
CEF	rad	-0.004638	-0.00024	-0.004398	-
REF	rad	3.983641	4.0156	-0.031959	-

* Actual Minus Nominal

** Times Referenced to Inertial Mode Start.

Platform and Control

The roll maneuver as indicated on the azimuth resolver was executed properly during the 2 to 19 second period.

The pitch resolver came into the instrumented range at guidance enable minus 28.5 seconds and crossed over zero 22 seconds later. After the staging disturbance the resolver settled at zero at guidance enable plus 16 seconds.

All servo errors were normal and less than ∮ 0.8 minutes deviation.

Gyro drifts measured prior to launch were:

Gross Azimuth	-0.62°/Hr	Precountdown
Roll Fixed	∮0.13°/Hr	Precountdown
Gross Pitch	∮0.64°/Hr	Hangar N

These values are consistent with previous measurements. Redundant gyro torquing currents were normal. Maximum amplitude oscillation of 67°/Hr peak to peak occurred at 230. This channel also indicated an oscillation of less than 1 cps at 26°/Hr peak to peak amplitude during the interval from internal power transfer to reset.

Gyro temperatures remained stable through the flight, with the following deviations from the buoyancy temperatures at launch:

Roll/Azimuth	(602)	±0.45°C
Pitch	(601)	±0.95°C

The binnacle heater measurement cycled twice from full on to off during the flight.

Accelerometer scale factors measured during the precount were as follows:

X	Y	Z
2.00052	Not Measured	1.99826

These values are consistent with previous measurements.

Computer

Computer operation was satisfactory. All discretes were issued at the proper times. Computer voltages were normal. Computer temperature rose from 31°C to 37°C during the flight.

Yaw steering was normal. Missile yawed approximately 7° left with 2° right overshoot. Steering was essentially complete at guidance enable plus 38 seconds.

The data checker tests of the range tape recorded during the flight indicated that the computer operation was satisfactory. Four errors occurred and Data Bridge Correction was required at 115 seconds for approximately 2 seconds due to noise on RF No. 3.

Alignment Countdown Set

This missile was launched using the Lot III OGE. Operation of this equipment was normal up to step 6.19 of the precountdown. During this step a computer "No-Go" occurred. The computer received no inputs until 29 seconds after start. It was established that at initiation of countdown both the Standby and the ready mode relays were energized. Twenty-nine seconds after the computer test start, the system stepped normally to torque mode, de-energizing the ready mode relays and feeding the proper inputs to the computer. The system was returned to stand-by and another countdown initiated and the computer run was completed successfully. After the flight every attempt was made to

latch up this relay again and simulate the condition. This could not be accomplished. The condition is being investigated.

Accelerometer zeros were within the specified tolerances before launch, as measured with the A-CS, indicating proper operation of the zeroing loops.

Function	Nominal	Compensated Nominal	Measured	Error
X offset	0.667	0.6684498	0.6627010	-0.0057488
X zero	1.000	-	Not measured*	-
Y zero	1.000	-	0.99953856	-0.00046144
Z zero	65.25407	65.19523	65.19701	+0.00178

* X zero was not measured due to the ACS advancing to Step 14 before a reading was taken.

Instrumentation

All channels of the Analog Signal Converter operated satisfactorily. ASC temperature remained constant at 21.5°C throughout the flight.

The Digital Signal Converter performance was satisfactory.

Telemetry quality on this flight was fair. The normal drop at staging occurred and additional noise occurred on RF 3 at 115 seconds.

Four ASC channels had GD/A temperature monitoring signals mixed with them. Two of these, yaw steering and azimuth resolver, exhibited a bias of approximately 0.25 volts. The same bias was observed on Missile 32E, which also had this configuration.

MOD III RANGE SAFETY AND INSTRUMENTATION SYSTEM

Performance of the Mod III System was satisfactory. During the minus count primary Range Safety was transferred to the Mod III System. In addition, it was the primary source for the generation of the ASCO discrete. A good IIP plot was presented to the Range Safety Officer from liftoff to approximately 382 seconds. The ASCO inhibit switch remained in the "OFF" position for the entire flight, and the ASCO discrete was generated properly at 289.397 seconds.

Telemetered data indicated satisfactory operation of the Missileborne Mod III E Beacons.

Performance of the individual subsystems was as follows:

Track Subsystem

The performance of the Track Subsystem was satisfactory. The missile was tracked off the pad in automatic monopulse mode as planned. Track lock was continuous from liftoff to 411 seconds when the limits of range tracking was reached. The operator immediately ran the track range gate back and succeeded in reacquiring the missile, tracking it for an additional 60 seconds.

During the sustainer phase the received signal strength average -58 dbm and the peak-to-peak tracking errors were 0.08 mils in azimuth and 0.05 mils in elevation.

Rate Subsystem

The performance of the Rate Subsystem was satisfactory.

From liftoff to approximately 50 seconds the received signal was noisy due to flame effects and multipath reception. Rate was locked on the missile at 9 seconds; however, due to the noisy signal the lateral rate flags were intermittent until 42 seconds. From this time, except for the usual loss of signal at staging, rate lock was continuous until 410 seconds.

During the sustainer phase the received signal strength average was -86 dbm and the lateral rate readout variation was the normal 2 bits peak-to-peak. The rate data provided the computer during powered flight was of good quality.

Mod III Computer

The computer operated satisfactorily during the countdown and ensuing flight with no malfunctions observed. A simulated flight re-run was made with no deviations from the real time results.

Acceptable data for IIP calculations were received continuously from -6 seconds until switching from flight ready at +382 seconds. The following impact point was calculated from data gathered between VCO and Retro-Rocket Firing.

	Mean Miss Distance	Standard Deviation	Deviation of the Mean
Cross Range	0.62 NM Right	± 0.45 NM	± 0.17 NM
Down Range	1.23 NM Short	± 0.39 NM	± 0.15 NM

RE-ENTRY VEHICLE

A Mark 5 Mod 2 Re-entry Vehicle was flown on 4F and was the first re-entry vehicle of its type to be flight-tested on an Atlas.

The C-band beacon and Telemetry System operated satisfactorily until blackout. Link 255.1 was lost during blackout. This vehicle incorporated a record retransmit system and, therefore, did not have a recoverable data cassette. One apparent malfunction occurred approximately 80 seconds prior to re-entry vehicle separation. At this time the pre-arm, electrical disconnect and mechanical disconnect monitors operated. This problem area is being investigated. The physical separation monitor operated satisfactorily and at the proper time. From a quick-look basis, it appears that the re-entry vehicle test objectives were only partially satisfied.

The following is a chronology of re-entry vehicle in-flight events:

Function	Time
Range Zero	0
Lockout Switch 2	65.7
Lockout Switch 1	79.7
Pre-arm (R/V Monitor)	225.5
Electrical Disconnect (R/V Monitor)	225.5
Mechanical Disconnect (R/V Monitor)	225.5
Pre-arm (ARMA Computer)	308.7
Physical Separation (R/V Monitor)	312

PROPELLANT TANKING

Fuel tanking was accomplished on 18 November 1961. Flight level was obtained in the following manner. Fuel was tanked to the Level High Primary Probe plus 23 gallons at Sequence I (tanking pressure) and tanking secured. Fuel tank pressure was then increased to flight pressure, the pressure sensitive pre-valves were opened and the engine plumbing was filled. Tank pressure was then decreased to Sequence I and 33 gallons of fuel were added to return to the original level.

On 22 November 1961 the fuel level had decreased and 33 gallons of fuel were topped. This placed the fuel level 23 gallons above the Level Low Primary Probe prior to LO2 Tanking. The decrease in fuel level from 18 November to 22 November 1961 represents a level change of 102 gallons. This level decrease is too great to be attributed to a fuel density change. Since the fuel density at ignition cannot be determined, the ignition fuel weight of 76,200 pounds is based on tank volume and the 18 November fuel density of 49.88 lbs/ft^3.

LO2 tanking was concluded with a successful LO2 slug transfer of 44.0 seconds duration as measured from the activation of the Topping High Probe to the activation of the 100 percent Slug Cutoff Probe. LO2 slug discharge pressure peaked at 346 psig and remained there until slug cutoff. The 100 per cent slug uncovered 0.32 seconds prior to 1 Inch Motion indicating that the LO2 level at ignition was approximately 700 pounds above the 100 per cent Slug Cutoff Probe.

Based on tank volume and an ignition LO2 density of 70.15 lbs/ft^3 there were approximately 174,200 pounds of LO2 aboard at ignition.

Weather Data

	Fuel Tanking	Ignition
Ambient Temperature	60.9°F	73.8°F
Barometric Pressure	29.930 Inches of Hg	30.010 Inches of Hg
Relative Humidity	86 Per cent	62 Per cent
Wind Velocity and Direction	3 Knots - N	11 Knots - E-SE
Total Cloud Cover	7/10	9/10

TELEMETRY

Satisfactory data were obtained from the Telemetry System until well beyond powered flight. The usual dropout of the telemetry signal occurred after staging and lasted 0.5 seconds. Operation of RF No. 4 was satisfactory.

RF 1 Channel 11 temperature measurements yielded invalid data after plus 295 seconds. Channel 11 Segment 27 became noisy and below normal level from plus 295 seconds till loss of signal. Channel 11 Segment 25 became noisy and spiked below 100 per cent level from plus 296 seconds till loss of signal.

There were fourteen measurements that did not yield valid data throughout the flight.

Measurement	Description	Comment
A 77 A	Jettison Rail End Radial	Remained above 100 per cent after staging invalidating D 1 V on RF 1 Channel 6S.
M 177 T	V1 Thor Retro Nozzle	Below zero until plus 152 seconds, valid after 152 seconds.
M 180 T	V2 Thor Retro Case	Below Zero Prior to Launch.
A 36 A	Booster Thrust Section Longitudinal Acceleration	Failed at 0.5 seconds.
P 529 D	S. Main LO2 Valve	Failed at Plus 4 seconds.
H 130 P	S. Hyd Pump Discharge	Remained at zero.
P 38 P	B2 Fuel Pump Discharge	Remained at zero.
A 32 T	V2 Heat Shield Calorimeter	Remained at -2 per cent.
P 517 P	Sustainer Fuel Injection Manifold	Improper levels.
H 185 P	Sustainer Hydraulic Pump Inlet Pressure	Invalid after sustainer cutoff.

Measurement	Description	Comment
P 830 D	Sust PU Valve Position	Intermittent.
P 530 T	Sustainer LO2 Pump Inlet	Over 100 per cent.
P 531 C	SGG Fuel Check Valve	Bias level shifts occurred during flight.

Missile 4F contained three Bendix Mod 7 FM Telemetry packages and one Time Transposition Telemetry package which included a Speidel Corp. Mod 003 Recorder-Reproducer System. Basic telemetry channel assignment is given in General Dynamics/Astronautics Report AE 61-0123-04.

LANDLINE INSTRUMENTATION

The Landline Instrumentation System provided satisfactory data until liftoff.

Difficulty was encountered in obtaining accurate sequence data from the EA records as the records were not switched to fast time until one second prior to liftoff. The Brown records also were not switched until one second prior to liftoff.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The flight was successful.

2. The re-entry vehicle telemetry playback transmitter signal was not received after blackout during re-entry.

Recommendations

1. Review pre-flight re-entry vehicle tests, flight data, and dynamic environment of lofted trajectory for possible explanation of loss of post blackout playback signal from the re-entry vehicle.

COUNTDOWN TIME VERSUS EVENTS

This test was scheduled for a 150 minute countdown and started at 1230 EST as planned. There were four holds totaling 64 minutes which resulted in a 214 minute countdown. These holds were as follows:

1. At -70 minutes (1430 EST), for 40 minutes, to remove and secure the service tower and for an apparent Guidance System problem. Service tower removal had been delayed in order to replace the jettison plug on Scientific Passenger Pod Serial No. 22 which would not properly mate with the connector. The jettison plug replacement was completed at -71 minutes (1349 EST). At 1405 EST the hold was extended in order to evaluate a possible Guidance computer problem. The Guidance System was reported "Go" at 1429 EST and the countdown was resumed at -70 minutes at 1430 EST.

2. At -45 minutes (1455 EST), for 15 minutes, to continue the investigation of the Guidance problem. The cause of the Guidance problem, improper mode sequencing, could not be determined and it was decided to continue the countdown with this condition existing. The countdown was resumed at -45 minutes at 1510 EST.

3. At -35 minutes (1520 EST), for 7 minutes, due to malfunction of a re-entry vehicle accelerometer. It was decided to launch without obtaining this accelerometer data and the countdown was resumed at -35 minutes at 1527 EST.

4. At -3 minutes 30 seconds (1558.30 EST), for approximately 90 seconds, to determine the status of the Azusa System. The Mark II Ground Station was unable to lock-on the transponder after it was turned on at -13 minutes (1549 EST). It was decided to launch without Azusa and the countdown was resumed at -3 minutes 30 seconds at 1600 EST. There were no further holds required.

The following notations were made by an observer in the blockhouse.

EST	Countdown Time	Countdown Procedure	Event
1228	T-152		Jettison Plug On Scientific Passenger Pod Serial No. 22 Will Not Mate With Connector.

EST	Countdown Time	Countdown Procedure	Event
1230	T-150	T-150	Countdown Started.
		T-150	Propellant Utilization Sensor Response Checks Started.
		T-150	Re-entry Vehicle Telemetry and Beacon To "External".
1234	T-146		Propellant Utilization Sensor Response Checks Completed Satisfactorily.
1240	T-140	T-140	GAP Test Preparations Started.
1243	T-137		Jettison Plug Will Be Cut Off and Replaced.
1245	T-135		AIG Telemetry Check Completed.
1247	T-133	T-134	GAP Test Started.
1248	T-132	T-130	Re-entry Vehicle Telemetry and Beacon To "Internal".
1257	T-123		GAP Test Completed Satisfactorily.
1259	T-121	T-131	Telemetry Internal Battery Voltage Check Completed Satisfactorily.
1301	T-119	T-120	Range Safety Command Tests Started.
1309	T-111		Range Safety Command Tests Completed Satisfactorily.
1310	T-110	T-110	Electrical Connection of Red Destruct Box Started.
1317	T-103		Electrical Connection of Red Destruct Box Completed.
		T-110	Electrical Connection of Retro-rockets Started.

EST	Countdown Time	Countdown Procedure	Event
1319	T-101		Electrical Connection of Retro-rockets Completed.
1323	T-97		Measurement S 223 D Is Reading Zero.
1327	T-93	T-105	Guidance Accelerometer Measurement Started.
1330	T-90	T-90	Flight Control Systems Test Started.
			Service Tower Removal and Securing Delayed For Anticipated Hold At -70 Minutes.
1335	T-85	T-85	Helium Pressure Storage Preparation Started.
1338	T-82		AIGS Landlines May Be Removed.
			Estimate 15 Minutes To Replace Scientific Passenger Pod Plug.
1341	T-79		Flight Control Systems Test Completed.
1346	T-74		Will Hold At -70 Minutes For Estimated 15 Minutes.
1349	T-71		Scientific Passenger Pod Plug Work Completed.
1350	T-70H		Holding to Remove Service Tower From Test Stand.
1353			Raising Service Tower Floors.
1400			Measurement S 223 D Is Operating Properly.
1402		T-90	Service Tower Removal Started.

EST	Countdown Time	Countdown Procedure	Event
1405			Hold Extended Additional 10 Minutes To Evaluate Possible Guidance Computer Problem. Service Tower Will Be Held On Transfer Table Until Problem Is Resolved.
1413			Hold Extended Additional 15 Minutes For Guidance.
1429			Guidance Is "Go".
1430	T-70		Countdown Resumed.
1435	T-65	T-65	Landline Electrical Calibrations Started.
		T-65	Mod III E Beacon Checks Started.
1443	T-57		Will Attempt To Duplicate Guidance Problem - Personnel Dispatched To Transfer Room.
1449	T-51		Landline Electrical Calibrations Completed.
			T-50 Minute AIG Computer Check Will Be Delayed Until Completion of Guidance Investigation.
1453	T-47		Will Hold At -45 Minutes For Guidance.
1455	T-45H		Holding For Guidance Problem - Estimate 10 Minute Hold Duration.
1505			Extend Hold Additional 5 Minutes.
			Will Not Continue Problem Investigation But Will Perform -105 Minute System Countdown Test.
1510	T-45		Countdown Resumed.
		T-45	LO2 Tanking Preparations Started.

EST	Countdown Time	Countdown Procedure	Event
1517	T-38	T-40	AIG Computer and Programmer Check Started.
1518	T-37		Guidance Status "Go".
1519	T-36		LO2 System Ready For Tanking.
1520	T-35H		Holding For Re-entry Vehicle Accelerometer Problem.
1525			AIG Computer and Programmer Check Completed Satisfactorily.
1526			Status Check - All Reports "Go".
1527	T-35		Countdown Resumed.
		T-35	Autopilot System Final Check Started.
		T-35	LO2 Tanking Started.
1534	T-28		Range Forecasts Clear Launch Area.
1539	T-23	T-23	Azusa Check Started.
1540	T-22	T-22	Range Safety Command Final Test Started.
1541	T-21		Five Glitches Observed On 95 Per cent Fuel Primary EA Pen.
1542	T-20	T-20	Telemetry Final Warmup Started.
		T-20	Re-entry Vehicle Beacon On External Power.
		T-20	Scientific Passenger Pod No. 3 Telemetry Warmup Started.
1544	T-18	T-18	AIG Computer Check Started.
		T-35	Holddown Hooks Retracted.

EST	Countdown Time	Countdown Procedure	Event
1548	T-14		Autopilot System Final Check Completed.
1549	T-13		Azusa Ground Station Unable To Lockon Signal.
	T-12		AIG Computer Check Completed Satisfactorily.
1550		T-12	Re-entry Vehicle Telemetry On "External".
1552	T-10	T-10	Telemetry/Range Safety Command AGC Check Started.
		T-10	Final Propellant Utilization Check Started.
1553	T-9		Final Propellant Utilization Check Completed Satisfactorily.
			Telemetry/Range Safety Command AGC Check Completed Satisfactorily.
1555	T-7	T-7	Forecast Final Range Clearance From AMR.
1556	T-6	T-6	Scientific Passenger Pod No. 3 To "Internal".
1557	T-5	T-5	All Communications Switch to Channel 1.
	T-4:36		Azusa Reported "No-Go" By AMR.
	T-4:30	T-4:30	Squibs Disarm Switch to "Off".
	T-3:50	T-3:50	Status Check - All Reports "Go" Except Azusa "No-Go".
1558:30	T-3:30H		Holding To Evaluate Azusa System Status.
1600	T-3:30		Countdown Resumed - Will Proceed With Azusa "No-Go".

EST	Countdown Time	Countdown Procedure	Event
		T-3:30	Telemetry to "Internal".
1601	T-3:00	T-3:00	Timer Off - Ready Switch to "Ready".
1602	T-2:45	T-2:45	Shutdown Power Switch to "Arm".
1602	T-2:15	T-2:15	Re-entry Vehicle Beacon and Telemetry To "Internal".
1602	T-2:05	T-2:05	Commands to "Internal".
1603	T-2:00	T-2:00	Re-entry Vehicle to "Ready".
1603	T-1:55	T-1:55	Autopilot to "Arm".
1603	T-1:50	T-1:50	Turning Water Systems "On".
1603	T-1:45	T-1:45	Commands to "Arm".
1603	T-1:40	T-1:40	Range Ready Switch "On".
1603	T-1:35H	T-1:35	T-1 Minute 35 Seconds and Holding Momentarily.
		T-1:35	All Pre-start Lights Are Green.
		T-1:35	Slug Start.
1603	T-1:35	T-1:35	T-1 Minute 35 Seconds And Counting.
		T-1:35	Starting Flight Pressurization.
1603	T-1:15	T-1:15	Autopilot Programmer Reset.
1603	T-1:10	T-1:10	Missile to Internal Power.
1603	T-1:05	T-1:05	Missile Helium to "Internal".
1604	T-0:60H	T-0:60	T-60 Seconds And Holding Momentarily.
			Slug Complete.

EST	Countdown Time	Countdown Procedure	Event
1604	T-0:60	T-0:60	T-60 Seconds And Counting.
1604	T-0:55	T-0:55	Water Full Flow.
1604	T-0:50	T-0:50	Status Check - All Reports "Go".
1604	T-0:30	T-0:30	Close LO2 Ground Fill and Drain Valve.
		T-0:30	All Launch Commit Lights Are Green.
1604	T-0:05H	T-0:05	T-5 Seconds and Holding Momentarily.
		T-0:05	Commit Armed Light "On".
		T-0:05	All Recorders To "Fast".
	T-0:05	T-0:05	T-5 Seconds and Counting.
1604:11			Range Zero.

MISSILE CONFIGURATION

Airframe

"F" Series Airframe with no insulation bulkhead. Thor Retro-Rockets were installed in the vernier engine fairings. The missile 4F Airframe is essentially the same as "E" Series versions with two significant modifications.

A structural provision for one additional helium storage sphere has been incorporated in the booster section. Missile 4F was manufactured without the non-structural bulkhead and insulation pad to improve the overall missile reliability.

Azusa System

A type B-1A coherent carrier transponder operated in conjunction with the Mark II Ground Station. An elliptical horn antenna was mounted on the tripod boom in Missile Quad IV.

Electrical System

Missile Electrical power was supplied by a remotely activated, primary-type, Eagle-Picher main missile battery and Leland rotary inverter. Vernier Engine No. 2 had an unwrapped electrical harness with isolation resistors in the wiring to the servo valve.

Flight Control System

The square canister configuration with forward rate gyro canister containing pitch and yaw rate gyros was flown on Missile 4F. This was the second flight using the 27-41002-855 Gyro Canister which incorporated the Phase Rotation Detector System in addition to the Spin Motor Rotation Detector (SMRD) System (previously flown on Missile 32E). This was the sixth flight using the 27-45045-5 Forward Rate Gyro Canister (previously flown on Missiles 2F, 25E, 26E, 30E, 32E) and the fourth flight using the 27-41000-831 "Transistors" Servo Canister (previously flown on Missiles 25E, 30E, and 32E). This was the second flight using the 27-41001-933 Programmer Canister (previously flown on Missile 2F).

Guidance System

An ARMA Lot IV Missile Guidance Set (MGS) was flown on Missile 4F. Lot III Ground Equipment was used for preflight checkout of the MGS.

Hydraulic System

The Hydraulic System is comprised of independent booster, sustainer/vernier, and vernier-solo sub-systems. These provide the power necessary to gimbal the thrust chambers during flight. Minor components such as flow limiters, relief valves, disconnects and associated plumbing are used in each system. The vernier-solo system incorporates an accumulator type hydraulic power supply.

Impact Predictors

Azusa System and Mod III Range Safety and Instrumentation System were utilized for impact prediction purposes.

Pneumatic System

An additional shrouded tank-pressurization helium storage sphere (or bottle) will be carried aboard Series F missiles. The additional sphere is required because of the short helium loading time in the Series F operational countdown. The 6 minute loading interval does not allow the helium to be chilled sufficiently by the liquid nitrogen shroud to store the required amount of helium in the five spheres used with Series E missiles. The additional bottle will be loacated in the Quad I and II area of the booster section. An AiResearch Series F boiloff valve was flown. Fluidgenics regulators were used to control pressures in the fuel and LO2 tanks.

Propellant Utilisation System

The Accustica Propellant Utilisation System was utilized on this missile and is essentially the same as the system flown on Missiles 26E and on. This system uses a 400 cps signal for excitation of the PU valve position feedback transducer and a 5-card computer.

Propulsion System

Rocketdyne MA-3 Liquid Propulsion Engine System was flown.

Range Safety Command System

The standard system employed two ARW-62 Receivers, a power and signal control unit, arming switch, and destruct package. System electrical power was supplied by two manually-activated, secondary-type, Yardney batteries which were contained within a single canister.

Telemetry

PAM/FM/FM System was comprised of four telemetry packages, three Bendix R and D telemetry packages and a one time transposition telemetry package which included a Speidel Corp. Recorder Reproducer System. One accessory package was carried to furnish transducer excitation and signal conditioning circuits, two diplexers, a ring coupler, and two cavity-type antennas.

Four airframe telemetry links were operational at 227.7, 229.9, 232.4 and 235.5 mc. System electrical power was supplied by three remotely-activated, primary-type, Eagle-Picher batteries.

Mod III Range Safety and Instrumentation System

The Missileborne Mod III E Instrumentation Beacon System operated in conjunction with the Mod III Ground Station. The missileborne antenna was mounted on the tripod boom in missile Quad IV.

Propellant Tanking

Astronautics "E" Series Propellant Tanking System incorporating four ultrasonic fuel sensors, four LO2/GO2 detectors, a Propellant Loading Control Unit (PLCU) in the blockhouse, and 200-400 gallon LO2 slug.

Re-entry Vehicle

A Mark 5, Mod 2 Re-entry Vehicle was flown with special adapter and a ballasted transition section incorporated to simulate weight of the Mark 4 Re-entry Vehicle. The re-entry vehicle carried two telemetry links, a Sandia simulated warhead and a playback recorder but no data cassette or recovery aids. The re-entry vehicle also carried a C-Band radar beacon and a one-pound SOFAR bomb.

Penetration System

This was the second "F" Series flight using the Mod I pod (previously flown on Missiles 18E, 21E, 90D and 2F). The pod consisted of a base structure; one 12-inch diameter launch tube; safety, arming and timing system; instrumentation; and a protective aerodynamic fairing. The pod electrical and instrumentation systems were powered by a secondary-type battery contained within the pod. The pod was mounted in Missile Quad II with its center line 31 degrees from the X axis of the missile.

Scientific Passenger Pods

SP Pod No. 3 was carried for 8 assigned experiments on geophysical studies.

SP Pod No. 22 was carried to obtain empirical data on fuel core heating rates for bodies of a given configuration and material during re-entry.

HISTORY OF SM-65F MISSILE NO. 4F

Atlas Missile 4F arrived at AMR by air on 12 August 1961. Transfer from the IOC trailer to the R and D trailer was completed and the missile was placed in the south bay of Hangar "J". On 14 August the missile was moved to Hangar "K" for MAPCHE Testing. Missile weighing was completed on 5 October, transfer to Complex 11 and erection were accomplished on 6 October. Pre-flight testing was accomplished in accordance with planning documented in Report AA 61-0102, Flight Test Directive, Atlas Missile 4F.

Significant events concerning Missile 4F from arrival at AMR to launch are delineated below:

Date	Event
23 October 1961	Successful Propellant Tanking.
13 November 1961	Unsatisfactory Flight Acceptance Composite Test (due to problems with Autopilot, Guidance and Telemetry).
18 November 1961	Satisfactory FAC Test.
25 November 1961	Flight.

Significant difficulties are presented by system below:

Landline Instrumentation

No significant problems were encountered.

Missile Electrical

IR No. 679499 written to replace diodes in inverter (CR-2). Results of the MAPCHE missile electrical test were used to test inverter after diode change.

Range Safety Command

No significant problems were encountered.

Azusa

IR No. 679455 written against Azusa Aljax broken at waveguide near V1 engine. Aljax was repaired using existing connector and new inter-seal.

TVA A32684 Thor-Retro Rockets squib check-out was corrected due to a wrong callout.

Azusa transponder installed was found to be "NO GO" on missile FACT, with evidence of loss of phase lock or carrier frequency shift. The canister was replaced with same results. Antenna coupler installed and radiating horn directed to ground station indicated satisfactory results. Although possibility of multi-path interference existed, this transponder was also replaced.

During pre-count checks flight transponder check was satisfactory. During normal countdown operations, transponder was found to be "NO GO" prior to and at liftoff. Data Reports indicated later lock-in during launch plus time.

Telemetry

Accessory package circuits for BLIP module concerning Measurement D 1 V were found to have capacitor polarity reversal resulting in loss of signal and bias on channel. The capacitor was correctly installed.

Excessive operational problems were encountered with Measurement P 531 O, and A 36 A transducers due to sensitivity to ground external power and transducer failures. Transducer was replaced and Measurement A 36 A failed again during flight.

Short on Channel 2-4 circuit in accessory package causing component failure of ARMA M. G. S. This item was corrected.

Transducer failure on Measurements H 185 P, H 212 P, and H 224 P due to evident over-pressure prior to or after arrival at AMR. The transducer was replaced.

Incorrect weld joint used on Measurement A 32 T resulted in damage during functional check. This was corrected. A good deal of difficulty was encountered in getting Measurement P 830 D to work properly.

Flight Control

Upon applying power to the Autopilot System, it was noted that the programmer zero light was not on but all other high power switch lights were on. Power was turned off and back on and the programmer light was present with no other lights. When A/P power was turned back on the programmer would run only at X10. Since nothing was done to remedy this problem because it disappeared by itself, the X10 wires going to the programmer were cut at the programmer to prevent possible failure in flight.

During rework of ADF pod wiring an open solder joint was found in plug 305U31P1. This solder joint was repaired.

During the plus time of the FACT, it was noted that Switch No. 17 of the A/P programmer had an output which resembled the timing pulse. This indicated that + 28 V was absent from the control diode. The programmer was replaced.

Mod III E Instrumentation Beacon

During the first FACT on 11-13-61, three problems were found. P 51, on the back of the console, was loose, and plug 304U1P1 pin D on the rate beacon was bent. The harness was IR'd (#650380) and dispositioned to straighten connector and remate; the rate beacon was removed and replaced with S/N 20 CG. The third problem was that the MIBITS equipment 14th pulse was adjusted out. This was readjusted correcting the problem.

Water was found in Umbilical 600U5 on 11-15-61 and was purged.

During the second FACT on 11-18-61, three problems were encountered. P 4, which is not properly wired causing low meter readings, was plugged in the MIBITS equipment. This was removed correcting the problem. The second problem was that Pin F 304U1P2 was intermittent. The plug was removed, the pin straightened, and the plug remated correcting the problem. The third problem was low power return from both beacons. A piece of tin foil was found in the coupler which was removed, correcting the problem.

Hydraulics

During MPACHE testing in the Hangar, V-2 engine developed a leak at the yaw gimbal shaft seal bleed port. After erection, V1 developed the same leak and both engines were subsequently replaced. Replacement engines contained the leather back-up rings. There was slight seepage from both new engines, but was well within 5 drops/5 minute specification.

All Clemco vernier actuators were replaced with reworked Clemco actuators, after receipt of missile at AMR. V2 yaw actuator failed during MAPCHE testing in the hangar, and was replaced.

The Royal Jet Hydraulic Unit was received at AMR with two outstanding IR's attached. Unit was rejected at AMR due to lack of evidence that cleanliness had been maintained on unit during removal and transportation to AMR. The hydraulic oil and filters were changed and fluid circulated using internal filters and external filter banks. The fluid was drained again and reservoir flushed with alcohol. After refilling unit the fluid was again circulated several hours before acceptable samples were obtained to support testing.

The airborne sustainer hydraulic pump was changed due to leakage from vendors outlet pressure fitting.

V1 actuator hydraulic return line required replacing due to a broken "B" nut. Evidence indicated over-torque as its cause.

Propellant Utilization

No significant problems were encountered.

Propulsion

A major problem resulted from cleanliness not being maintained in the LO2 system. The San Diego torque paint on plugs of the following ducts was broken:

B-1 LO2 low pressure duct between staging disconnect and A/B fill and drain valve.

B-2 LO2 low pressure duct from staging disconnect to B-2 pump inlet.

B-2 low pressure duct, first section above staging disconnect.

These ducts were removed and sent to the lab for solvent extraction tests. The tests showed the ducts not to be contaminated. They were cleaned and replaced.

A major problem involved replacing the fuel staging valves because the flow fairing on the rear of the valve poppet came loose during a San Diego pet test.

Another problem was the replacement of the vernier fuel flex supply line because of a fatigue pet test failure in San Diego.

The prevalve bellows shields were replaced because they were not per B/P, which calls for fiberglass and the ones installed were asbestos.

On X-1 day, while inspecting the vernier engines, it was found that the V-2 flex conduit interfered with the vernier LO2 supply line. The AN 743-13 bracket on the clamshell was repositioned eliminating the interference.

Complex Mechanical

Prior to missile tanking tests, PCU checkout revealed a burned out 40940 RF filter to PCU valve No. 20. IR #679420 was written to replace this filter. Because of a previous filter failure, it was decided to replace all existing filters as parts became available. Failure of these filters have occurred on Complex 11 only and seem to be traced with excessive spraying of the PCU with water during a water test in February 1961. Failure of any of these filters can cause serious pressurization control problems.

Complex Electrical

Upon rework of the Airesearch boil-off valve it was discovered that the feed thru connector required for probe installation had #20 sized pins while the wire from the LO2 probes was #16 AWG. Installation was IR'd to remove 9 of 19 strands to allow #16 gage wire to be installed in #20 pins.

The R/F filter on valve #20 of the PCU burned out. Due to moisture present all filters were IR'd and replacements were ordered. Filters on valves 20, 22, 24, and 25 have been replaced.

Umbilical 600U7 was found to be internally shorted on several pins.

During installation of the protection rubber guard on 600P12, moisture was found in the connector. An EO was written to drill drain holes in mounting bracket.

The fuel probe installed in the missile did not agree with available paper. P/C 27-72268-801B did not require a quick disconnect, but the disconnect was installed. Probe was reidentified to correct problem.

During LO2 Tanking (10-23-61) two problems occurred:

Operational power light could only be turned on with test position key. This was corrected by correcting wiring at MAPCHE hydraulic console.

There was no 95% indication at the LO2 console and pumps LA and LB did not turn off. This problem was caused by an incorrect cross-over setting in the PLCU cabinet due to a faulty test box (EWR 31268). The cross-over points were re-set and a set of K30 (LO2 low topping) contacts were installed in the LA-LB pump circuitry to provide secondary pump cut-off.

The circuit breaker on the prop. valve heater panel was broken. This was replaced per IR #650865.

Propellant Loading

No significant problems were encountered.

Re-entry Vehicle

Significant pre-flight events:

Event	Date
Mark 5 Mod 2-2 arrived at AMR.	2 August 1961
Final systems test accomplished.	6 November 1961
Re-entry vehicle accepted for flight by Air Force	15 November 1961
Re-entry vehicle mated to Atlas 4F	20 November 1961

Airframe

Considerable rework was required on pod cooling ducts received for pod cooling modifications due to manufacturing errors and/or deviation from B/P specs.

Pneumatics

After Fuel Tanking Test Stage II pressure, fuel was observed leaking from 204U5J1-1, Acoustica Plug Boss. A Gasket was replaced after detanking. This boss again leaked after readiness tanking; however, leakage was stopped by torquing the nut per B/P specification.

Penetration

No significant problems were encountered.

Scientific Passenger Pods (SPP)

During launch precount, it was found that the plug on the squib cable (PB 5493-223-1) which mates with the connector on the conax valve were both female connectors. The cable plug was removed and a male connector added.

Inertial Guidance

On 22 August 1961 commenced Missile 4F MGS check out using CTP-40. Could not turn on ASC. ASC S/N 020 was replaced with ASC S/N 7150013.

On 12 and 13 October 1961 when attempting to start the airborne computer via MAPCHE, it was noticed that after completion of the computer drawer self-

check, the computer did not start. Checks revealed that there was no 28 vdc at TB 29-1. Investigation revealed a wiring error in ECP-35 Drawer 1A2A1. The wiring error was corrected and the diodes which burned out were replaced due to this error. Results were then satisfactory. MAPCHE Checkout was conducted satisfactorily.

Three computer problems were run before supporting MAPCHE. A digital "NO-GO" was obtained on two Flight Board problems and one digital "NO-GO" was obtained on the IG Board problem. Commenced "NO-GO" indication investigation.

On 17 and 19 October 1961 ran four computer problems through the Flight Board. All were "GO's". Amp output was noticed when the system was first turned on. When the system warmed up, the magnetic amp output returned to normal. A bad channel was suspected in the ASC. ASC S/N 7150013 was replaced with ASC S/N 7150047.

On 20 and 24 October 1961 the new ASC S/N 7150047 exhibited the same symptoms as the old ASC. When a computer problem was initiated, ASC Channels 11 and 18 would increase in steps as the discretes occurred. Pod wiring was checked and no discrepancies were found. Umbilical cable was found to be defective and was replaced.

On 13 November 1961 completed FAC Test. Computer failed during the two hold countdown problems, and Channel 27 of the ASC (Pitch Steering Resolver) read zero output even during gimbal travel. Z Accelerometer Scale Storage was out of tolerance.

Replaced Computer S/N 7230125 and ASC S/N 7150047 with Computer S/N 7230021 and ASC S/N 7150049. After replacing components, four computer problems were run with all "GO" results. The new ASC exhibited the same symptoms; no output from Channel 27. Investigation of this problem showed telemetry cable 30236 was shorting the channel to ground. Repaired same, thereby rectifying the ASC problem.

On 17 November 1961 supported Integrated Test and obtained a YSS "NO-GO". Reran the problem and received two "GO's" and another "NO-GO". Checked the YSS amplifier for proper adjustment. The Z Scale Storage problem was traced to a slipping clutch on motor R10. The motor was replaced.

On 18 November 1961 conducted FAC Test, with system in a "GO" configuration. A YSS "NO-GO" indication was obtained during the GAP Test. It was found that the "NO-GO" logic was not giving a computer "NO-GO" indication when it occurs. The telemetry and sanborn runs were analysed and found the YSS levels were within tolerance. In checking the YSS amplifier, it was found to be adjusted too high.

Re-adjusted to the proper value and ran integrated runs with A/P. Resulting in a "GO" condition.

On 20 November 1961 completed X-1 Day System Checks (CTP-37). It was discovered that when the SECO discrete button was depressed on the A/P monitor panel, during a GAP Test, the 1A1A1 Computer drawer sensed this as a premature SECO time and YSS "NO-GO" indication was generated, as the YSS level was not yet set up for SECO sample.

APPENDIX

FLUID CHEMICAL ANALYSIS

	Unit	Sample	Specification
Liquid Oxygen			
Purity	Per cent	99.55	99.2 Minimum
Hydrocarbons			
As Methane	ppm by vol.	26	75.0 Total Maximum
As Acetylene	ppm by vol.	None	1.5 Maximum
Particle Count			
350 - 500	Microns	0	2 Maximum
500 +	Microns	0	0
Fibers, 25 x 6000	Microns	0	0
Total Solids	Microns	0	2.5 Maximum

This item is within specifications.

Gaseous Helium			
Purity	Per cent	99.95+	99.95 Minimum
Hydrocarbons			
As Methane	ppm by vol.	None	75.0 Total Maximum
As Acetylene	ppm by vol.	None	1.5 Maximum

This item is within specifications.

Gaseous Nitrogen			
Purity	Per cent	99.85	99.5 Minimum
Hydrocarbons			
As Methane	ppm by vol.	None	75.0 Total Maximum
As Acetylene	ppm by vol.	None	1.5 Maximum

This item is within specifications.

Lubricating Oil			
Viscosity at 100°F	Centistokes	12.7	11.0 Minimum
Viscosity at 210°F	Centistokes	3.3	3.0 Minimum
Flash Point	°F	440	400.0 Minimum
Viscosity Index		149	80.0 Minimum
Appearance		Pass	Uniform. No sediment or suspended matter.

This item is within specifications.

	Unit	Sample	Specification
Trichloroethylene			
Appearance		Pass	Clear
Color		Pass	Not dyed.
Odor		Pass	Characteristic
Specific Gravity	@68°/68°F	1.470	1.454 to 1.476
Distillation			
Initial	°C	189	187.7 Minimum
Dry Point	°C	189	190.4 Maximum
Water Content	@14.0°F	Pass	Cloudless
Non-volatile	Per cent	0.001	.002 Maximum
Hydrocarbons	Per cent	0.0002	

This item is within specifications.

Fuel, RP-1			
Initial Boiling	°F	364	Report
10 Per cent	°F	394	365 - 410
50 Per cent	°F	421	Report
90 Per cent	°F	458	Report
End Point	°F	486	525 Maximum
Residue	Per cent	0.9	1.5 Maximum
Loss	Per cent	0.6	1.5 Maximum
Flash Point	°F	142	110 Minimum
Gravity	°API	43.5	42.0 - 45.0
Particle Count			
350 - 500	Microns	0	20 per liter maximum
500 +	Microns	0	0
Fibers, 25 x 6000	Microns	0	0
Inert Solids	Microns	1.0	1.5 Maximum

This item is within specifications.

Hydraulic Fluid - Booster			
Flash Point	°F	215	200 Minimum
Color		Clear	Clear
Viscosity	Centistokes	8.3*	8.5 Minimum
Dye		Red	Red

	Unit	Sample	Specification
Hydraulic Fluid - Booster (con.)			
Particle Count			
10 - 25	Microns	1,620	5,500 Maximum
26 - 50	Microns	420	1,200 Maximum
51 - 100	Microns	60	300 Maximum
100 - 500	Microns	1	20 Maximum
500 +	Microns	0	0 Maximum
Fibers, 100 - 1000	Microns	1	20 Maximum
Fibers, 1000 +	Microns	0	0 Maximum

* This item is out of specifications.

Hydraulic Fluid - Sustainer			
Flash Point	°F	216	200 Minimum
Color		Clear	Clear
Viscosity	Centistokes	8.35*	8.5 Minimum
Dye		Red	Red
Particle Count			
10 - 25	Microns	2,520	5,500 Maximum
26 - 50	Microns	480	1,200 Maximum
51 - 100	Microns	120	300 Maximum
100 - 500	Microns	4	20 Maximum
500 +	Microns	0	0 Maximum
Fibers, 100 - 1000	Microns	6	20 Maximum
Fibers, 1000 +	Microns	0	0 Maximum

* This item is out of specifications.

REFERENCE DOCUMENTS

Flight Test Plan - Missile 4F	AE 60-0141
Flight Test Program - SM-65 Series F, R & D Missiles	AZC-27-005
Detailed Test Requirements (AFBMD/STL)	STL-OR-60-0000-19028
Flight Test Directive (FTWG)	AA 61-0102

Additional reports which may be referenced for further information regarding this missile are listed below:

Reports	Approximate Issue Date (time after test)
General Dynamics/Astronautics, San Diego, Calif	
Flight Test Evaluation Report	14 days
AFBMD/STL, Inglewood, Calif.	
Flight Summary Report	8 - 12 weeks
ARMA, CCO	
CCO Quick Look Report	7 - 10 days
American Bosch ARMA Co., Garden City, N.Y.	
Flight Test Evaluation Report	30 days
AVCO RAD, Wilmington, Mass.	
Evaluation Report	30 days
General Electric, Syracuse, N.Y.	
Evaluation Report of Mod III Instrumentation System with Missile 4F	6 - 10 weeks
Acoustica Associates, Inc., Los Angeles, Calif.	
Flight Test Evaluation Report	30 days
Aeronutronics, Newport Beach, Calif.	
Flight Test Report	30 days

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SERIAL NUMBERS OF SYSTEM COMPONENTS

Azusa Transponder

Canister, Serial No. 731-0097

Re-entry Vehicle

Mark 5 Mod 2-2, Serial No. L25929

Range Safety Command System

Range Safety Command Receiver No. 1, Serial No. AF 61-164
Range Safety Command Receiver No. 2, Serial No. AF 61-163
Range Safety Command Receiver No. 1, Battery, Serial No. 011-0507
Range Safety Command Receiver No. 2, Battery, Serial No. 011-0506
Range Safety Command Power and Signal Control Unit, Serial No. 011-0038

Propulsion System

Sustainer, Serial No. 222754
Booster No. 1, Serial No. 112817
Booster No. 2, Serial No. 112818
Vernier No. 1, Serial No. 332826
Vernier No. 2, Serial No. 332767

Electrical System

Main Missile Battery, Serial No. 105-0400
Inverter, Serial No. 007-0102
Power Changeover Switch, Serial No. 003-0042

Mod III E Instrumentation Beacon System

Rate Beacon, Serial No. 6E9020
Pulse Beacon, Serial No. 6E1038

Telemetry System

Telemeter RF No. 1, Serial No. 105-0016 (0874)
Telemeter RF No. 2, Serial No. 105-0011 (0816)
Telemeter RF No. 3, Serial No. 107-0019 (0873)
Telemeter RF No. 4, Serial No. 3
Telemeter RF No. 1, Battery, Serial No. 105-0571
Telemeter RF No. 2, Battery, Serial No. 105-0569
Telemeter RF No. 3, Battery, Serial No. 105-0570
Accessory Canister, Serial No. 104-0023

Flight Control System

Gyro Canister, Serial No. 107-0171 (206)
Forward Rate Gyro Canister, Serial No. 018-0102 (99)
Servo Canister, Serial No. 110-0127 (250)
Programmer Canister, Serial No. 010-0031 (258)

Propellant Utilization System

Computer, Serial No. ACA-0086
Stillwell-LO2, Model SL 191, Serial No. 0158
Stillwell-Fuel, Model SL 192, Serial No. 0158

Pneumatics System

LO2 Tank Pressure Regulator, Serial No. 107-0287
Fuel Tank Pressure Regulator, Serial No. 103-0243

Inertial Guidance System

Platform, Serial No. 7210009
Control, Serial No. 7220077
Computer, Serial No. 7230021
Analog Signal Converter, Serial No. 7150049
Digital Signal Converter, Serial No. 7140081

Penetration System

Pod, Serial No. 022

Scientific Passenger Pods, Serial No. 3 and Serial No. 22

SIGNIFICANT DATES DURING TESTING OF "A" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Captive	Erection	FRF	Flight	AMR Range No.	Comments
4A	12-8-56	16	3-20-57	6-3-57	6-11-57	896	Engine shut down at 29.9 seconds of flight. Missile destroyed at 50.1 seconds.
6A	4-4-57	14	8-2-57	9-20-57	9-25-57	1422	Engine shut down at 47.7 seconds of flight. Missile destroyed at 74 seconds.
12A	11-1-57	16	11-30-57	12-11-57	12-17-57	2148	Successful flight. Impacted approximately 490 nm downrange.
10A	7-10-57	12	9-27-57 10-27-57 11-6-57	*11-27-57 **12-10-57 1-4-58	1-10-58	10	Successful flight. Impacted approximately 542 nm downrange.
13A	12-6-57	16	1-17-58	***1-31-58	2-7-58	222	Engine shut down prematurely at 117.8 seconds of flight due to flight control system failure. Missile broke up at 167 seconds.
11A	12-20-57	12	1-25-58	2-6-58	2-20-58	449	Engine shut down prematurely at 124 seconds of flight due to flight control system failure. Missile broke up at 126.5 seconds.
15A	1-6-58	14	2-26-58	3-22-58	4-5-58	634	Engine shut down prematurely at 105 seconds of flight due to B1 turbopump failure. Missile remained intact and impacted approximately 200 miles downrange.
16A	2-5-58	12	3-17-58	****4-18-58 5-22-58	6-3-58	1261	Successful flight. Impacted approximately 480 nm downrange.

* Premature cutoff at 8 seconds. Both booster chambers damaged, necessitating replacement.

** Full duration, but damaged B1 chamber, necessitating replacement.

*** FRF terminated prematurely, but considered satisfactory.

**** Prematurely terminated due to APS shutdown.

SIGNIFICANT DATES DURING TESTING OF "B" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3B	6-12-58	11	5-29-58	*6-23-58 **6-27-58 7-8-58	***7-12-58 7-19-58	1564	Missile broke up at 42 seconds of flight. Due to failure of the yaw rate gyro.
4B	5-31-58	13	6-13-58	7-15-58	8-2-58	1382	Successful flight. Impacted approximately 2346 nm downrange.
5B	5-30-58	11	7-22-58	8-20-58	8-28-58	1383	Successful flight. Impacted approximately 2453 nm downrange. First completely closed loop guidance system flight.
8B	7-31-58	14	8-4-58	9-6-58	9-14-58	1511	Successful flight. Impacted approximately 3151 nm downrange.
6B	7-17-58	13	8-14-58	9-10-58	9-18-58	1512	B1 turbopump failed at 80.8 seconds after lift-off. Missile exploded two seconds later.
9B	8-7-58	11	9-12-58 ##9-30-58	#10-4-58 ###10-24-58 ####10-27-58	11-17-58	1513	Depletion of fuel supply caused simultaneous premature sustainer and vernier shutdown. Missile impacted 800 to 900 nm short of intended impact point. First flight of modified booster turbopumps.
12B	9-4-58	14	11-8-58	11-24-58	11-28-58	1730	Successful flight. Impacted approximately 5506 nm downrange.
10B	10-22-58	11	11-20-58	****[illegible]-58 ****12-10-58 12-12-58	12-18-58	1729	Successful flight. Missile placed into orbit.
13B	12-4-58	14	12-6-58	12-22-58	1-15-59	30	Flight prematurely terminated due to unexplained difficulties starting at 100 seconds after liftoff. Missile impacted 170 nm downrange. There was no telemetry system aboard this missile.
11B	8-22-58	11	12-23-58	1-20-59	2-4-59	29	Successful flight. Impacted approximately 3122 nm downrange.

* Automatic cutoff initiated by container overspeed/underspeed trip 1.96 seconds after BOG links break.

** Automatic cutoff initiated by container overspeed/underspeed trip 1.88 seconds after BOG links break.

*** Prematurely terminated by an automatic cutoff 4.98 seconds after BOG links break.

**** Vernier ignition only.

\# Manual cutoff at 6.49 seconds.

\## After installation of "C" Series power pack in Hangar "J".

\### Automatic cutoff initiated by container overspeed/underspeed trip 1.0 seconds after BOG links break.

\#### Full duration, but engine compartment fire delayed schedule approximately 10 days.

SIGNIFICANT DATES DURING TESTING OF "C" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3C	10-31-58	14	11-4-58 *11-23-58	12-17-58	12-23-58	2301	Successful flight. Impacted approximately 3883 nm downrange.
4C	11-9-58	14	1-6-59	1-19-59	1-27-59	10	Although impact was close to intended point, the guidance system did not function.
5C	1-31-59	14	2-6-59	None	4-20-59	25[illegible]	Missile exploded at 174 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
7C	4-12-59	12	4-13-59	None	5-18-59	761	Booster engine shutdown prematurely at 131 seconds of flight. Missile was unstable for remainder of flight.
8C	5-7-59	14	5-18-59	***6-22-59 **7-9-59	#7-15-59 7-21-59	4303	Successful flight. Impacted in target area 4385 nm downrange. RVX-2 Re-entry Vehicle recovered.
11C	7-15-59	14	7-25-59	8-14-59	8-24-59	2121	Successful flight. Impacted almost 5 miles long in MILS net due to residual thrust after vernier cutoff. Re-entry vehicle was recovered.

* After power pack modification.

** Two successful Flight Readiness Firings performed.

\# Ignition achieved twice. Manual cutoff for 1st attempt in vernier ignition phase. Second attempt terminated by release timer.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Countdown	Erection	FRF	Flight	AMR Range No.	Comments
[illegible]	3-[illegible]-59	13	3-27-59	3-27-59	4-14-59	1082	Booster section exploded 27 seconds after liftoff due to failure of airborne LO2 fill and drain valve to close. Missile destroyed at 37 seconds.
[illegible]	[illegible]-59	14	4-13-59	5-6-59	**5-15-59 5-18-59	1754	Missile exploded at 65 seconds due to improper launcher operation which resulted in loss of fuel tank pressure.
[illegible]	[illegible]-59	13	4-[illegible]-59	5-19-59	6-6-59	1753	Missile exploded at 160 seconds due to a malfunction at staging. Probable cause was improper operation of the fuel staging valve.
[illegible]	4-[illegible]-59	11	5-11-59	**7-14-59 7-22-59	7-29-59	2002	Successful flight. Impacted 4384 nm downrange less than 1/2 mile from target in MILS net.
[illegible]	5-[illegible]-59	13	6-10-59	7-[illegible]-59	8-11-59	2003	Successful flight. Impacted in MILS net less than 1 mile from target.
[illegible]	5-27-59	13	8-17-59	9-9-59	9-16-59	2106	Successful flight. Impacted 2 miles short of target in MILS net due to failure of vernier solo hydraulic package.
[illegible]	[illegible]	11	9-[illegible]-59	None	10-6-59	2120	Successful flight. Impacted in MILS net less than 1/2 mile from target.
[illegible]	[illegible]-59	13	9-21-59	None	10-9-59	[illegible]	Successful flight. Impacted in MILS net less than 1 1/2 miles from target.
[illegible]	9-[illegible]-59	11	10-[illegible]-59	None	10-29-59	2344	Due to malfunction of V2 engine at staging. Impacted approximately 14 miles short of target point.
[illegible]	9-[illegible]-59	13	10-[illegible]-59	None	11-4-59	4208	Unsuccessful. A/B IP failure prevented Station 5 IP system from acquiring the missile. Range safety cutoff caused R/V to impact approximately 260 miles short of target.
[illegible]	[illegible]-59	11 14 13	7-11-59 9-[illegible]-59 11-7-59	None	11-24-59	2108	Successful although re-entry vehicle did not separate. Impacted in MILS net.
[illegible]	10-[illegible]-59	13	11-[illegible]-59	None	12-8-59	[illegible]	Successful flight. Impacted 1/2 mile from target in MILS net.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
[illegible]	11-20-59	13	12-10-59	None	12-18-59	16	Successful flight. Delivered a Mk-2 Re-entry Vehicle within 3 nm of target over a 5500 nm range.
[illegible]	12-8-59	13	12-[illegible]-59	None	1-6-60	32	Successful flight. Delivered a Mk-3 Re-entry Vehicle within 3 miles of target over a 5500 nm range.
[illegible]	12-17-59	13	1-11-60	None	1-26-60	54	Successful flight. RVX4-A2 Re-entry Vehicle impacted approximately 1/2 mile from target in MILS net.
[illegible]	1-5-60	13	1-30-60	None	2-11-60	320	Successful flight. Mk-3 Re-entry Vehicle impacted less than 1 1/2 nm from target over a 5500 nm range.
[illegible]	12-8-59	11	12-21-59	[illegible]-4-60 2-23-60	[illegible]-4-60 3-8-60	17	Successful flight. First missile to use all-inertial guidance system open loop.
51D	1-30-60	13	2-15-60	None	3-10-60	775	Destroyed by fire and explosion immediately after liftoff.
[illegible]	2-19-60	11	3-10-60	None	4-7-60	301	Destroyed in the stand by fire and explosion during a launch attempt.
56D	3-3-60	12	4-11-60	None	[illegible]-12-60 5-20-60	1005	Successful flight. Delivered Mk-3 Re-entry Vehicle within 4 nm of target over an extended range of 7659 nm.
54D	2-25-60	11	5-13-60	None	6-11-60	615	Successful flight. Delivered Mk-3 Re-entry Vehicle 4300 nm downrange within 2.2 nm of target. First flight with AIG system providing active guidance functions.
62D	4-19-60	14	5-26-60	None	6-22-60	801	Impacted approximately 18 nm long due to failure of the vernier engines to shutdown when the guidance cutoff discrete was received.
57D	5-27-60	12	6-6-60	None	6-27-60	1002	Successful flight. Impacted within 1 nm of target in MILS net 4380 nm downrange.
60D	6-6-60	11	6-16-60	None	7-2-60	803	Inadvertent pressurizations of the engine tanks caused premature depletion of control helium. Re-entry vehicle impacted 40 nm short.
[illegible]	6-22-60	12	7-1-60	None	[illegible]-2-60 8-9-60	1003	Successful flight. Impacted within 4 nm of target in South Atlantic Ocean over the intermediate range of 6350 nm.

SIGNIFICANT DATES DURING TESTING OF "D" SERIES FLIGHT MISSILES AT AMR (Cont'd)

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
66D	6-14-60	11	7-7-60	None	8-12-60	1004	Successfully impacted re-entry vehicle within 2 nm of target. First Atlas to use AIG system with impact programmed for Station 12 MILS net.
76D	7-6-60	11	8-15-60	None	9-16-60	2817	Successfully placed RVX-2A Re-entry Vehicle within 5 nm of target. Second Atlas to use AIG System with impact in Station 12 MILS net.
79D	7-13-60	14	8-26-60	None	***9-15-60 9-19-60	802	Successful flight. Second Atlas to deliver a Mark 3 Re-entry Vehicle to target over an extended range of 7863 nm.
71D	8-19-60	11	9-25-60	None	10-13-60	1502	Successful flight. Impacted within 2 nm of target 4387 nm downrange. Last D-AIG Missile to be flight tested. RVX-2A Re-entry Vehicle recovered.
58D	2-27-60	12	3-7-60 8-24-60 10-3-60	None	10-22-60	613	Successful flight. Impacted within 1 nm of target 6350 nm downrange. The missile was flown without insulation and insulation bulkhead at the intermediate bulkhead with no adverse results.
83D	10-6-60	12	10-27-60	None	11-15-60	3503	Successful flight. Impacted less than 1 nm from target 4385 nm downrange. Data cassette recovered.
90D	12-14-60	12	12-20-60	None	1-23-61	3506	Successful flight. Last of "D" Series Weapon System flights. Impacted Mk-3 Mod 1B Re-entry Vehicle within 1/2 nm of target 4394 nm downrange.

* Launch aborted due to faulty release timer which initiated automatic cutoff.

** Test terminated by sustainer rough combustion cutoff circuitry.

*** Launch aborted 5.45 seconds after sustainer flight lockin because no release signal was generated.

\# Rerun due to Guidance System difficulties.

\## Engine cutoff prior to release due to erroneous callout in blockhouse.

\### Terminated by erroneous output from B2 primary RCC accelerometer.

\#### Terminated 1.53 seconds after sustainer flight lockin by the sustainer RCC system.

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SIGNIFICANT DATES DURING TESTING OF "E" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
3E	5-19-60	13	7-29-60	*9-23-60 10-3-60	10-11-60	1502	Malfunction in sustainer hydraulic system caused loss of missile after staging.
4E	7-18-60	13	10-2[illegible]-60	None	11-29-60	2800	Sustainer hydraulic pressure was lost at 41 seconds and caused missile to become unstable at booster cutoff. Sustainer thrust was lost at about 150 seconds.
8E	10-25-60	13	12-5-60	None	1-24-61	3504	Missile stability was not maintained after 161.8 seconds due to loss of engine servo control in flight control system. Sustainer engine shutdown at 249 seconds.
9E	11-11-60	13	1-30-61	None	2-24-61	3803	Successful flight. Impacted Mark 3 Mod II B Re-entry Vehicle within 600 yds. of aim point.
13E	1-15-61	13	2-27-61	None	3-13-61	403	Malfunction in PU system caused fuel depletion and premature shutdown of sustainer engine at 252 seconds.
16E	3-10-61	13	3-14-61	None	3-24-61	811	Failed to jettison the booster section because of premature depletion of engine control bottle helium pressure.
12E	12-20-60	11	2-16-61	None	5-12-61	424	Successful flight. Impacted Mark 5 Mod I Re-entry Vehicle within 0.5 mile of target at a range of 4388 miles. First "E" Series from Complex 11.
18E	3-30-61	13	4-6-61	None	5-26-61	813	Successful flight. Impacted Mark 4 Mod IV Re-entry Vehicle 1 mile of target at a range of 4388 nautical miles. *First "E" Series missile flown without insulation and insulation bulkhead at the intermediate bulkhead with no adverse results.*
17E	3-21-61	11	5-10-61	None	6-22-61	818	Unsuccessful flight. Malfunction in the Flight Control System caused loss of missile after 101 seconds.

* B2 lube oil pump shaft sheared. Test duration 14 seconds.

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SIGNIFICANT DATES DURING TESTING OF "E" SERIES FLIGHT MISSILES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
22E	6-4-61	13	6-14-61	None	7-6-61	1251	First "E" Series missile to be successfully flown to a maximum range target of 7863 nautical miles with impact within 2.1 nautical miles of target.
21E	6-24-61	11	7-5-61	None	7-31-61	1360	Impacted a Mark 5 Mod I Re-entry Vehicle within 3.1 nautical miles of target at a range of 4386 nautical miles.
26E	7-7-61	13	8-9-61	None	9-8-61	1803	Flight prematurely terminated when the sustainer engine shut down during booster jettison sequence. Operation of all other systems was satisfactory.
25E	7-18-61	11	8-14-61 9-7-61*	None	10-2-61	1252	Impacted a Mark 5 Mod I Re-entry Vehicle within 1.5 nautical miles of target. A scientific passenger pod containing Centaur Guidance System was carried for the first time. * Re-erected after complex modification to "F" Series.
30E	8-22-61	13	9-12-61	None	10-5-61	1804	Fourteenth "E" Series missile to be flight tested at AMR. First flight for a Mark 4 Re-entry Vehicle to a long range target of 7539 nautical miles. All prime objectives were satisfied.
32E	10-6-61	13	10-9-61	None	11-10-61		Unsuccessful flight due to a premature shutdown of the sustainer engine. Missile was destroyed by Range Safety Officer at 35 seconds.

SIGNIFICANT DATES DURING TESTING OF "F" SERIES FLIGHT MISSILES AT AMR

[redacted]	Arrival	Complete	Erection	RTF	Flight	AMR Launch No.	Comments
29	7-3-61	13	7-12-61	None	0-0-61	1965	First "F" Series Missile to be flight tested. Impacted Mark 5 Mod 1 Re-entry Vehicle 4380 nautical miles within 2.1 nautical miles of aim point.

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SIGNIFICANT DATES DURING TESTING OF MERCURY/ATLAS VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
10D	6-10-59	14	6-2-59 *7-22-59	9-3-59	9-9-59	2119	Successful flight although booster section failed to jettison. Project Mercury Capsule recovered.
50D	5-17-60	14	6-30-60	7-21-60	7-29-60	1506	Unsuccessful. Missile apparently destroyed after 60 seconds of flight. Mercury Capsule remained intact until impact.
67D	7-8-60	14	11-4-60	11-19-60	2-21-61	419	Successful MA-2 mission. Impacted Mercury Capsule as planned. First closed loop flight for ASIS. Capsule recovered.
100D	3-16-61	14	3-27-61	None	4-25-61	835	Unsuccessful. Missile was destroyed by range safety action 40 seconds after lift-off. This action was necessitated by the absence of the roll and pitch-over maneuvers.
88D	7-16-61	14	7-19-61	None	9-13-61	1234	Flight was successful. Capsule was placed in orbit; after one scheduled orbit capsule was recovered east of Bermuda. All objectives were satisfied.

* Returned to Hangar for booster power package replacement.

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SIGNIFICANT DATES DURING TESTING OF MIDAS VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
203	10-10-59	14	1-10-60	None	2-26-60	304	MIDAS I Booster shot. Atlas portion of flight was successful.
403	1-26-60	14	3-3-60	None	5-24-60	619	MIDAS II Booster shot. Atlas portion of flight completely successful.

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SIGNIFICANT DATES DURING TESTING OF RANGER VEHICLES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
111D	5-27-61	12	5-29-61	None	8-23-61	5050	Atlas/Agena Booster portion of flight was successful. Agena spacecraft orbit was not satisfied due to a malfunction in upper stage operation.
117D	9-17-61	12	9-19-61	None	11-18-61	4507	Atlas/Agena Booster portion of flight was successful. Agena spacecraft orbit was not satisfied due to a malfunction in upper stage operation.

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SIGNIFICANT DATES DURING TESTING OF ATLAS/ABLE LUNAR PROBES AT AMR

Missile	Arrival	Complex	Erection	FRF	Flight	AMR Range No.	Comments
9C	6-4-59	12	6-18-59 (8-17-59)*	9-24-59		3044	Destroyed by fire and explosion following premature cutoff during flight readiness firing.
80D	9-10-59	14	10-13-59	None	11-26-59	4122	Atlas/Able IV Lunar Probe. Atlas portion of flight was successful. Portions of Able failed at 47 seconds.
91D	8-10-60	12	9-3-60	None	9-25-60	3001	Atlas/Able V Lunar Probe. Atlas portion of flight was successful. Second stage engine operation unsatisfactory.
99D	10-15-60	12	11-17-60	None	12-15-60	4900	Unsuccessful. Flight was terminated after 74.5 seconds when the vehicle destroyed itself.

*Erected twice due to cancellation of test and subsequent return to hangar for storage.

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